证　明

CERTIFICATE

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国际申请号： PCT/CN02/00826

INTERNATIONAL APPLICATION NUMBER

国际申请日： 19 NOV 2002（19.11.02）

INTERNATILNAL FILING DATE

发明名称： Method and Apparatus for Connecting a Micro-Actuator to Driver Arm Suspension

TITLE OF INVENTION

申请人： SAE MAGNETICS(H.K.)LTD.

APPLICANT

中华人民共和国国家知识产权局局长

COMMISSIONER OF THE STATE INTELLECTUAL PROPERTY OFFECE OF THE PEOPLE'S REPUBLIC OF CHINA

王景川

二零零二年十二月三十日

DECEMBER. 30. 2002

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16.12月 2002(16.12.02)

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/CN 02/ 00 824

International Filing Date 19 NOV 2002 (19.11.02)

RO/CN 中华人民共和国国家知识产权局 PCT International Application

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* FPEL02150037

Box No. I TITLE OF INVENTION

Method and Apparatus for Connecting a Micro-Actuator to Driver Arm Suspension

Box No. II APPLICANT ☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

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Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

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☒ inventor only *(If this check-box is marked, do not fill in below.)*

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Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

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☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Sheet No. ...2...

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This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☒ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

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This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

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This person is:
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This person is:
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- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

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This person is:
- ☐ applicant only
- ☐ applicant and inventor
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The following designations are hereby made under Rule 4.9(a):

Regional Patent

☐ **AP** **ARIPO Patent:** GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, MZ Mozambique, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZM Zambia, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

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☐ **EP** **European Patent:** AT Austria, BE Belgium, BG Bulgaria, CH & LI Switzerland and Liechtenstein, CY Cyprus, CZ Czech Republic, DE Germany, DK Denmark, EE Estonia, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, SK Slovakia, TR Turkey, and any other State which is a Contracting State of the European Patent Convention and of the PCT

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☐ KP Democratic People's Republic of Korea .....
☐ KR Republic of Korea .....
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☐ LR Liberia
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The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application:* regional Office	international application: receiving Office
item (1)				
item (2)				
item (3)				
item (4)				
item (5)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office)* identified above as:

☐ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ item (4) ☐ item (5) ☐ other, see Supplemental Box

** Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):* ....

.....

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA / .....

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*

Date *(day/month/year)* Number Country *(or regional Office)*

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The following **declarations** are contained in Boxes Nos. VIII (i) to (v) *(mark the applicable check-boxes below and indicate in the right column the number of each type of declaration):*

Number of declarations

☐ Box No. VIII (i)	Declaration as to the identity of the inventor	:
☐ Box No. VIII (ii)	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	:
☐ Box No. VIII (iii)	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	:
☐ Box No. VIII (iv)	Declaration of inventorship (only for the purposes of the designation of the United States of America)	:
☐ Box No. VIII (v)	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	:

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application contains:

(a) the following number of **sheets in paper form:**

request (including declaration sheets)	:	5
description (excluding sequence listing part)	:	6
claims	:	6
abstract	:	1
drawings	:	7
Sub-total number of sheets	:	25
sequence listing part of description *(actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (b) below)*	:	
Total number of sheets	:	25

(b) sequence listing part of description filed in **computer readable form**

(i) ☐ only (under Section 801(a)(i))

(ii) ☐ in addition to being filed in paper form (under Section 801(a)(ii))

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which the sequence listing part is contained *(additional copies to be indicated under item 9(ii), in right column)*: .....

This international application is **accompanied** by the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item)*:

		Number of items
1. ☒	fee calculation sheet	:
2. ☒	original separate power of attorney	:
3. ☐	original general power of attorney	:
4. ☐	copy of general power of attorney; reference number, if any:	:
5. ☐	statement explaining lack of signature	:
6. ☐	priority document(s) identified in Box No. VI as item(s):	:
7. ☐	translation of international application into *(language)*:	:
8. ☐	separate indications concerning deposited microorganism or other biological material	:
9. ☐	sequence listing in computer readable form (indicate also type and number of carriers (diskette, CD-ROM, CD-R or other))	
	(i) ☐ copy submitted for the purposes of international search under Rule 13*ter* only (and not as part of the international application)	:
	(ii) ☐ *(only where check-box (b)(i) or (b)(ii) is marked in left column)* additional copies including, where applicable, the copy for the purposes of international search under Rule 13*ter*	:
	(iii) ☐ together with relevant statement as to the identity of the copy or copies with the sequence listing part mentioned in left column	:
10. ☐	other *(specify)*:	:

Figure of the drawings which should accompany the abstract: Fig 3

Language of filing of the international application: EN

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

CHINA PATENT AGENT (HONG KONG) LIMITED 中國專利代理(香港)有限公司 專利申請專用章

For receiving Office use only

1. Date of actual receipt of the purported international application: 19 NOV 2002 (19.11.02)

2. Drawings: ☐ received: ☐ not received:

3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:

4. Date of timely receipt of the required corrections under PCT Article 11(2):

5. International Searching Authority (if two or more are competent): ISA /

6. ☐ Transmittal of search copy delayed until search fee is paid

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FEE CALCULATION SHEET
Annex to the Request

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International Application No. PCT/CN02/00826

19 NOV 2002 (19.11.02)
Date stamp of the receiving Office

Applicant's or agent's file reference

Applicant

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE . . . . . CNY500 [T] — CNY 500.
2. SEARCH FEE . . . . . CNY1500 [S] — CNY 1500.

International search to be carried out by CN
(If two or more International Searching Authorities are competent to carry out the international search, indicate the name of the Authority which is chosen to carry out the international search.)

3. INTERNATIONAL FEE

Basic Fee

Where item (b) of Box No. IX applies, enter **Sub-total number of sheets** / Where item (b) of Box No. IX does not apply, enter **Total number of sheets**: 25

[b1] first 30 sheets . . . . . CHF650 [b1] — CHF 650.

[b2] _____ (number of sheets in excess of 30) x _____ (fee per sheet) = _____ [b2]

[b3] additional component (only if sequence listing part of description is filed in computer readable form under Section 801(a)(i), or both in that form and on paper, under Section 801(a)(ii)):

400 x _____ (fee per sheet) = _____ [b3]

Add amounts entered at b1, b2 and b3 and enter total at B . . . . CHF650 [B] — CHF 650.

Designation Fees

The international application contains 1 designations.

1 (number of designation fees payable *(maximum 5)*) x CHF140 (amount of designation fee) = CHF140 [D] — CHF 140.

Add amounts entered at B and D and enter total at I . . . . . CHF790 [I] — CHF 790.

(Applicants from certain States are entitled to a reduction of 75% of the international fee. Where the applicant is (or all applicants are) so entitled, the total to be entered at I is 25% of the sum of the amounts entered at B and D.)

4. FEE FOR PRIORITY DOCUMENT *(if applicable)* . . . . . [P] —

5. TOTAL FEES PAYABLE . . . . . CNY2000CHF790 TOTAL — CNY 2000. / CHF 790.

Add amounts entered at T, S, I and P, and enter total in the TOTAL box

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MODE OF PAYMENT

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See Notes to the fee calculation sheet

METHOD AND APPARATUS FOR CONNECTING A MICRO-ACTUATOR TO DRIVER ARM SUSPENSION

Background Information

[0001] The present invention relates to magnetic hard disk drives. More specifically, the present invention relates to a method of connecting the micro-actuator to the driver arm suspension.

[0002] In the art today, different methods are utilized to improve recording density of hard disk drives. **Figure 1** provides an illustration of a typical drive arm configured to read from and write to a magnetic hard disk. Typically, voice-coil motors (VCM) 102 are used for controlling a hard drive's arm 104 motion across a magnetic hard disk 106. Because of the inherent tolerance (dynamic play) that exists in the placement of a recording head 108 by a VCM 102 alone, micro-actuators 110 are now being utilized to 'fine-tune' head 108 placement. A VCM 102 is utilized for course adjustment and the micro-actuator then corrects the placement on a much smaller scale to compensate for the VCM's 102 (with the arm 104) tolerance. This enables a smaller recordable track width, increasing the 'tracks per inch' (TPI) value of the hard drive (increased drive density).

[0003] **Figure 2** provides an illustration of a micro-actuator as used in the art. Typically, a slider 202 (containing a read/write magnetic head; not shown) is utilized for maintaining a prescribed flying height above the disk surface 106 (See Figure 1). Micro-actuators may have flexible beams 204 connecting a support device 206 to a slider containment unit 208 enabling slider 202 motion independent of the drive arm 104 (See Figure 1). An electromagnetic assembly or an electromagnetic / ferromagnetic assembly (not shown) may be utilized to provide minute adjustments in orientation/location of the slider/head 202 with respect to the arm 104 (See Figure 1).

[0004] The physical and electrical coupling of a hard disk micro-actuator and magnetic head to a drive arm suspension can be difficult due to the environment within which it must operate. Using silver paste (high mercury-content epoxy) for physical/electrical attachment has drawbacks due to the viscous nature of epoxy under changing temperature and humidity. Under certain temperature and humidity conditions, the epoxy can deform, affecting the position of the slider and micro-actuator in relation to

the suspension arm. Additionally, silver ions or silver atoms in the silver paste may begin to migrate from the epoxy to the micro-actuator, affecting the performance of the micro-actuator. While other options for bonding the actuator to the suspension arm exist, such as gold ball bonding (GBB) and solder bump bonding (SBB), the rigidity of these options can lead to greater damage. In particular, the thinness of the piezoelectric transducer (PZT) surface layer of the micro-actuator can reduce the peel strength between the PZT layer and the bonding pad, causing the connection to crack and create an electrical short between the two. It is therefore desirable to support the micro-actuator and connect it to the suspension arm using a method that can create strong a connection without the risks of deformation.

Brief Description Of The Drawings

[0005] **Figure 1** provides an illustration of a drive arm configured to read from and write to a magnetic hard disk as used in the art.

[0006] **Figure 2** provides an illustration of a micro-actuator as used in the art.

[0007] **Figure 3** describes a hard disk drive head gimbal assembly (HGA) with a 'U'-shaped micro-actuator according to an embodiment of the present invention.

[0008] **Figure 4** provides an illustration of a U shape micro-actuator design according to an embodiment of the present invention.

[0009] **Figure 5** provides an illustration of the configuration of the coating application according to an embodiment of the present invention.

[0010] **Figure 6** provides an illustration of a step suspension according to an embodiment of the present invention.

[0011] **Figure 7** provides an illustration of step actuator according to an embodiment of the present invention.

Detailed Description

[0012] A system and method for connecting an actuator to a suspension element is disclosed. The actuator is electrically coupled using a silver paste. The silver paste is further covered by a coating application to provide structural support. A step, attached to either the actuator base or the suspension tongue, provides further structural support and maintains a gap between the actuator and the suspension element.

[0013] Illustrated in an upside-down orientation, **Figure 3** describes one embodiment of a hard disk drive head gimbal assembly (HGA) with a 'U'-shaped micro-actuator. In this embodiment, a slider 302 is bonded at two points 304 to a 'U'-shaped micro-actuator 306. In a further embodiment, the 'U'-shaped micro-actuator has a piezoelectric Lead Zirconate Titanate (PZT) beam (arm) 308 on each side of a ceramic support frame (actuator base) 310. The micro-actuator 306 is coupled to a suspension 312.

[0014] **Figure 4** illustrates one embodiment of the 'U' shaped micro-actuator 306. A support frame 310 supports two piezoelectric Lead Zirconate Titanate (PZT) beams 308. In one embodiment, the support frame is ceramic. The 'U' shaped micro-actuator 306 is connected to the slider element 302. In one embodiment, the micro-actuator may be a piezoelectric micro-actuator, an electromagnetic micro-actuator, an electrostatic micro-actuator, a capacitive micro-actuator, a fluidic micro-actuator, or a thermal micro-actuator.

[0015] **Figure 5** illustrates the coupling of the 'U' shaped micro-actuator 306 to the suspension element 312. In one embodiment, the 'U' shaped micro-actuator 306 is electrically coupled 502 to the suspension bonding pads 504 using a silver epoxy paste or resin. In a further embodiment, the slider 302 is electrically coupled 506 to the suspension bonding pads 508 using a silver epoxy paste or resin. In one embodiment, a coating application 510 covering the electric couplings for the micro-actuator 502 and the slider 506 provides physical support for these electric couplings. In particular, the coating application provides physical support for these electric couplings for the actuator element that can have movement independent of the movement of the HGA. In one embodiment, the coating application has a high glass transition temperature (Tg) (e.g., Tg > 120 degree Celsius), the temperature at which glassy solids transition to more flexible rubbery solids. In a further embodiment, the coating application has a high Young's modulus (E) (e.g., E > 0.6G Pa), the measure of the stiffness of a material. In one embodiment, the coating

application is an epoxy or a resin. The epoxy coating application can contain a filler material, such as metal, glass or a fiber material. The coating application protects the electric coupling from deformations caused by changes in humidity and temperature, as well as physical strain over time. The coating application can also prevent the migration of silver ions or atoms from the electric coupling into the electric layer of the PZT of the micro-actuator.

[0016] In a further embodiment of the present invention, a step configuration is implemented to further support the micro-actuator. The step configuration further reduces the amount of contact between the slider and the suspension during movement of the actuator. In one embodiment, the step configuration is implemented using a metal step 602 in the suspension tongue 312, as shown in **Figure 6**. In one embodiment, the step 602 is molded into the suspension tongue 312 at formation. In an alternate embodiment, a separate step piece 602 is coupled to the suspension tongue 312 before coupling the micro-actuator 306 to the suspension element 312. In one embodiment, the material for the step 602 is made of polyester, polyethylene, polymer, or ceramic. In a further embodiment, the step 602 is coupled to the suspension tongue 312 by epoxy, resin, anisotropic conductor film, or anisotropic conductive adhesive.

[0017] In one embodiment, the base of the micro-actuator 306 is thickened to create a step 702, as shown in **Figure 7**. The base step 702 of the micro-actuator 306 separates the micro-actuator 306 from the suspension 312 and maintains a parallel gap even during changes of temperature and humidity. In an alternate embodiment, the step 702 is created by attaching a separate step plate to the base of the micro-actuator 306. In one embodiment, the step configuration includes a first step element coupled to the micro-actuator and a second step element coupled to the suspension element. In an alternate embodiment, the step configuration includes a first step element created by thickening the base of the micro-actuator and a second step element is molded into the suspension tongue. In a further embodiment, the step 602 is coupled to the micro-actuator element 312 by epoxy, resin, anisotropic conductor film, or anisotropic conductive adhesive.

[0018] Although several embodiments are specifically illustrated and described herein, it will be appreciated that modifications and variations of the present invention are

covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

What is claimed is:

1. An actuator, comprising: an actuator element physically supported by and coupled to a suspension element at at least one application site of a bonding agent, the bonding agent covered by a coating application

2. The actuator of claim 1, wherein the actuator element is a micro-actuator.

3. The actuator of claim 2, wherein the micro-actuator is selected from a group consisting of a piezoelectric micro-actuator, an electromagnetic micro-actuator, an electrostatic micro-actuator, a capacitive micro-actuator, a fluidic micro-actuator, or a thermal micro-actuator.

4. The actuator of claim 1, wherein the bonding agent is a silver paste.

5. The actuator of claim 1, wherein the coating application has a glass transition temperature greater than 120 degrees Celsius.

6. The actuator of claim 1, wherein the coating application has a Young's modulus greater than 0.6G Pa.

7. The actuator of claim 1, wherein the coating application is an epoxy agent.

8. The actuator of claim 7, wherein the epoxy agent contains a filler ingredient.

9. The actuator of claim 8, wherein the filler ingredient is selected from a group consisting of metal, glass, or a fiber material.

10. The actuator of claim 1, further comprising a step element to maintain a parallel spatial relationship between the actuator element and the suspension element.

11. The actuator of claim 10, wherein the step element is created by thickening a portion of

the actuator element.

12. The actuator of claim 10, wherein the step element is coupled to a portion of the actuator element.

13. A system, comprising:

an actuator element;

a suspension element coupled to and supporting the actuator element by at least one application site of a bonding agent, the bonding agent covered by a coating application.

14. The system of claim 13, further comprising a magnetic head element coupled to the suspension element by at least one application site of a bonding agent, the bonding agent covered by a coating application.

15. The system of claim 13, wherein the actuator element is selected from a group consisting of a piezoelectric micro-actuator, an electromagnetic micro-actuator, an electrostatic micro-actuator, a capacitive micro-actuator, a fluidic micro-actuator, or a thermal micro-actuator.

16. The system of claim 15, wherein the micro-actuator is a piezoelectric micro-actuator.

17. The system of claim 13, further comprising a slider element coupled to the actuator element.

18. The system of claim 13, further comprising a hard drive to be read by the slider element.

19. The system of claim 13, wherein the bonding agent is a silver paste.

20. The system of claim 13, wherein the coating application has a glass transition temperature greater than 120 degrees Celsius.

21. The system of claim 13, wherein the coating application has a Young's modulus greater than 0.6G Pa.

22. The system of claim 13, wherein the coating application is an epoxy agent.

23. The system of claim 22, wherein the epoxy agent contains a filler ingredient.

24. The system of claim 23, wherein the filler ingredient is selected from a group consisting of metal, glass, or a fiber material.

25. The system of claim 13, further comprising a first step element to maintain a parallel spatial relationship between the actuator element and the suspension element.

26. The system of claim 25, wherein the first step element is created by thickening a portion of the actuator element.

27. The system of claim 26, wherein a second step element is molded into the suspension element.

28. The system of claim 25, wherein the first step element is coupled to a portion of the actuator element.

29. The system of claim 28, wherein a second step element is coupled to a portion of the suspension element.

30. The system of claim 25, wherein the first step element is molded into the suspension element.

31. The system of claim 25, wherein the first step element is coupled to a portion of the suspension element.

32. The system of claim 25, wherein the first step element is coupled to a portion of the suspension element using one of a group of materials comprising epoxy, resin, anisotropic conductive film, and anisotropic conductive adhesive.

33. The system of claim 25, wherein the first step element is coupled to a portion of the micro-actuator element using one of a group of materials comprising epoxy, resin, anisotropic conductive film, and anisotropic conductive adhesive.

34. A method, comprising:

coupling an actuator element to a suspension element using at least one application site of a bonding agent; and

covering the bonding agent with a coating application.

35. The method of claim 34, further comprising:

coupling a magnetic head element to the suspension element using at least one application site of the bonding agent; and

covering the bonding agent with the coating application.

36. The method of claim 34, wherein the actuator element is a micro-actuator.

37. The method of claim 36, wherein the micro-actuator is selected from a group consisting of a piezoelectric micro-actuator, an electromagnetic micro-actuator, an electrostatic micro-actuator, a capacitive micro-actuator, a fluidic micro-actuator, or a thermal micro-actuator.

38. The method of claim 34, wherein the bonding agent is a silver paste.

39. The method of claim 34, wherein the coating application has a glass transition temperature greater than 120 degrees Celsius.

40. The method of claim 34, wherein the coating application has a Young's modulus greater than 0.6G Pa.

41. The method of claim 34, wherein the coating application is an epoxy agent.

42. The method of claim 41, wherein the epoxy agent contains a filler ingredient.

43. The method of claim 42, wherein the filler ingredient is selected from a group consisting of metal, glass, or a fiber material.

44. The method of claim 34, further comprising maintaining a parallel spatial relationship between the actuator element and the suspension element using a first step element.

45. The method of claim 44, further comprising creating the first step element by thickening a portion of the actuator element.

46. The method of claim 45, further comprising molding a second step element into the suspension element.

47. The method of claim 44, further comprising coupling the first step element to a portion of the actuator element.

48. The method of claim 47, further comprising coupling a second step element to a portion of the suspension element.

49. The method of claim 44, further comprising molding the first step element into the suspension element.

50. The method of claim 44, further comprising coupling the first step element to a portion of the suspension element.

51. The method of claim 44, further comprising coupling the first step element to a portion of the suspension element using one of a group of materials comprising epoxy, resin, anisotropic conductive film, and anisotropic conductive adhesive.

52. The method of claim 44, further comprising coupling the first step element to a portion of the micro-actuator element using one of a group of materials comprising epoxy, resin, anisotropic conductive film, and anisotropic conductive adhesive.

Abstract

A system and method for connecting an actuator to a suspension element is disclosed. The actuator is electrically coupled using a silver paste. The silver paste is further covered by a coating application to provide structural support. A step, attached to either the actuator base or the suspension tongue, provides further structural support and maintains a gap between the actuator and the suspension element.

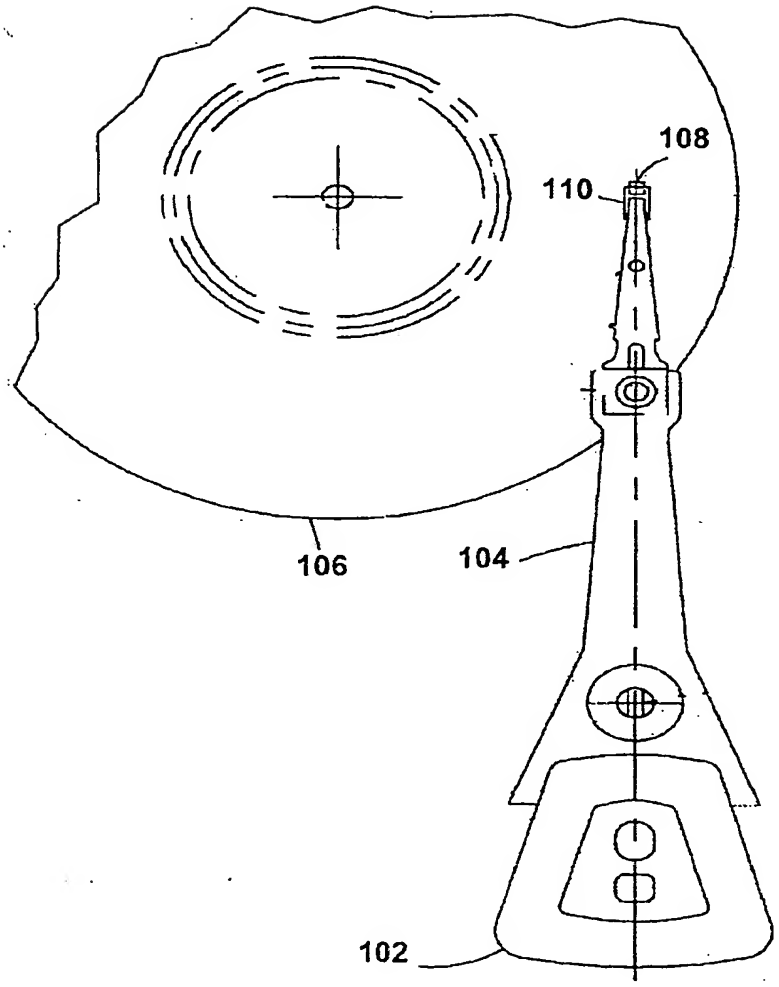

FIG. 1
Prior Art

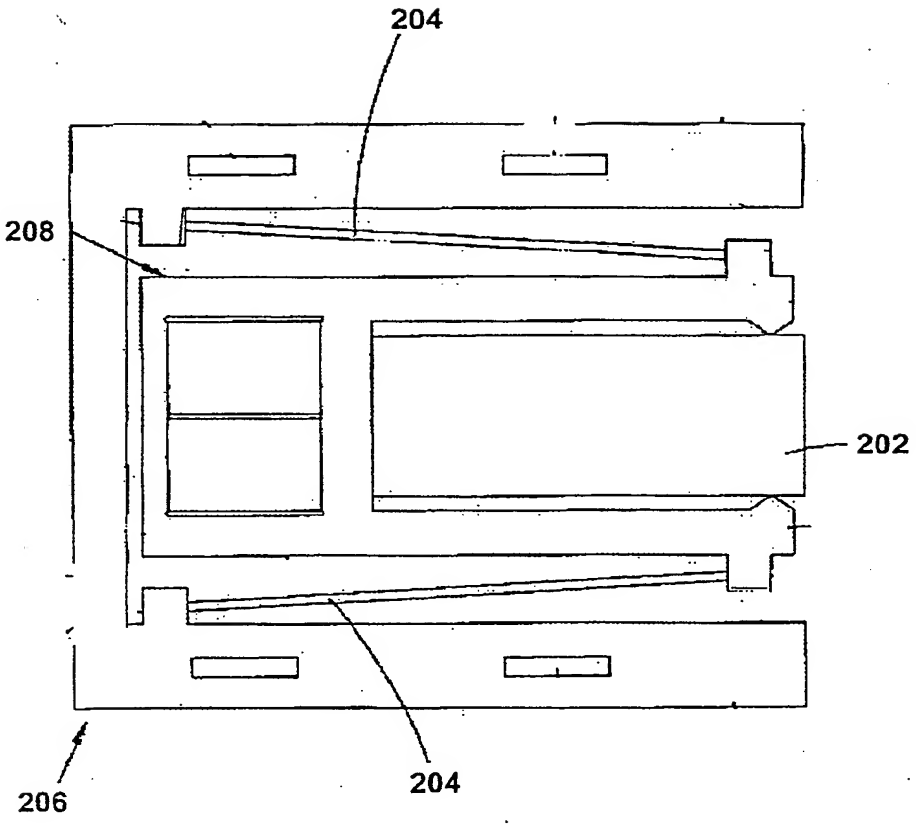

FIG. 2
Prior Art

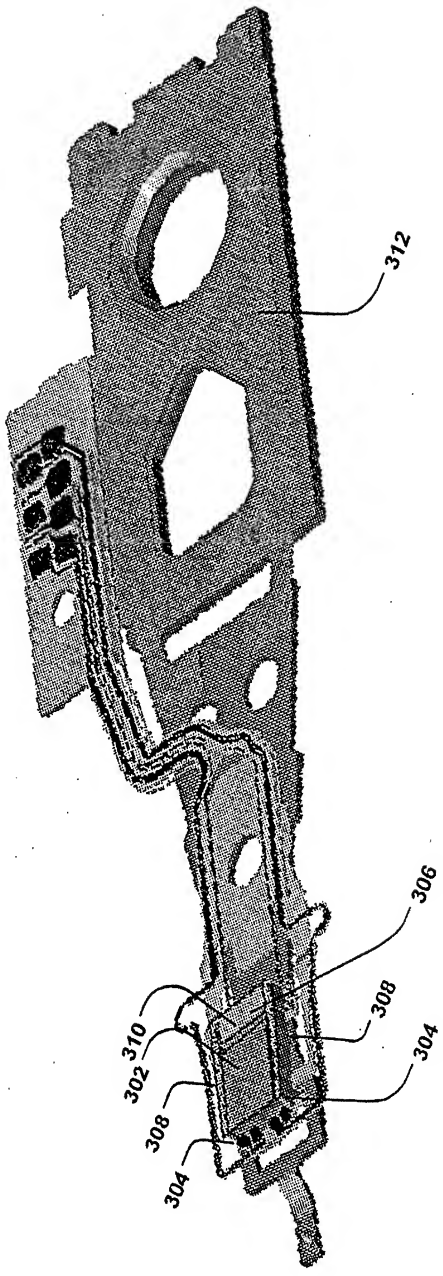

FIG. 3

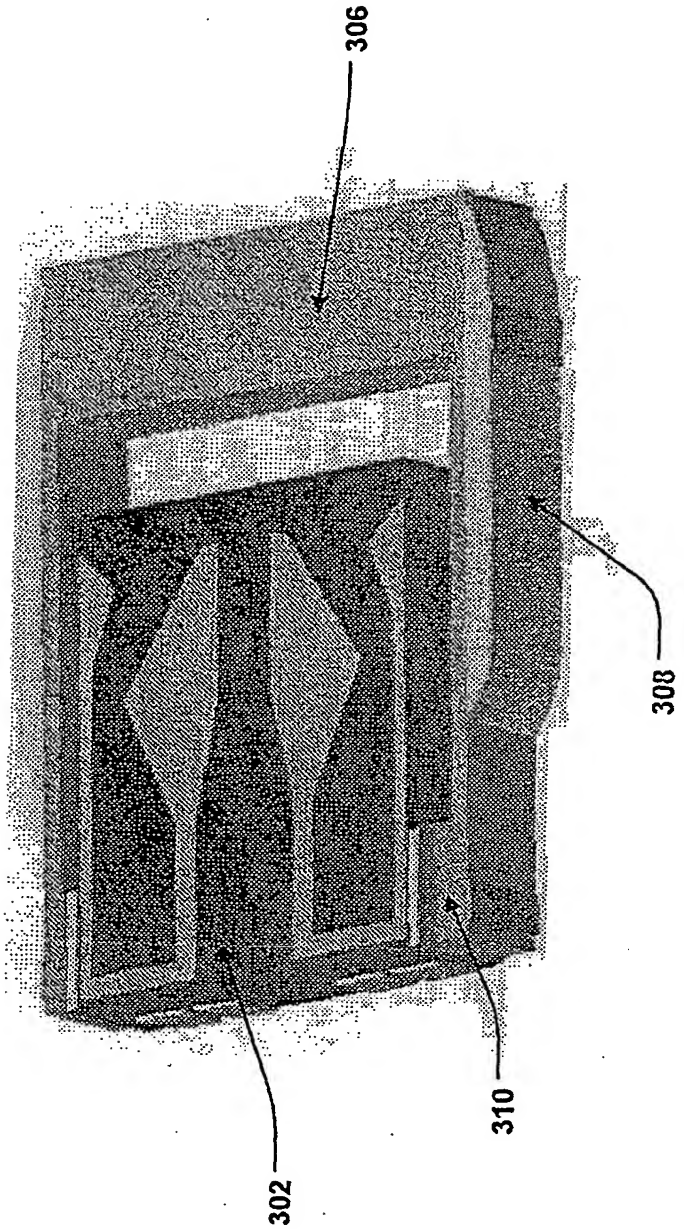

FIG. 4

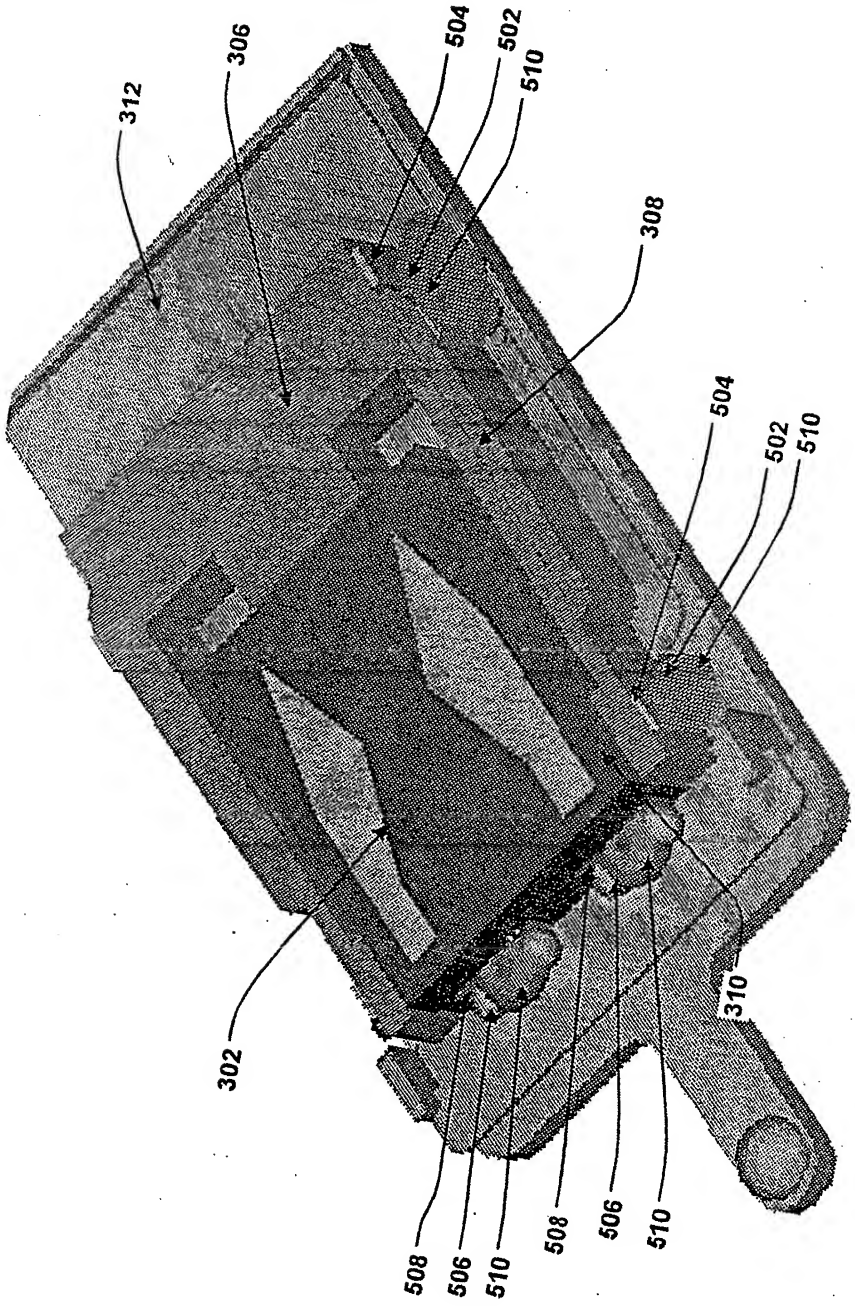

FIG. 5

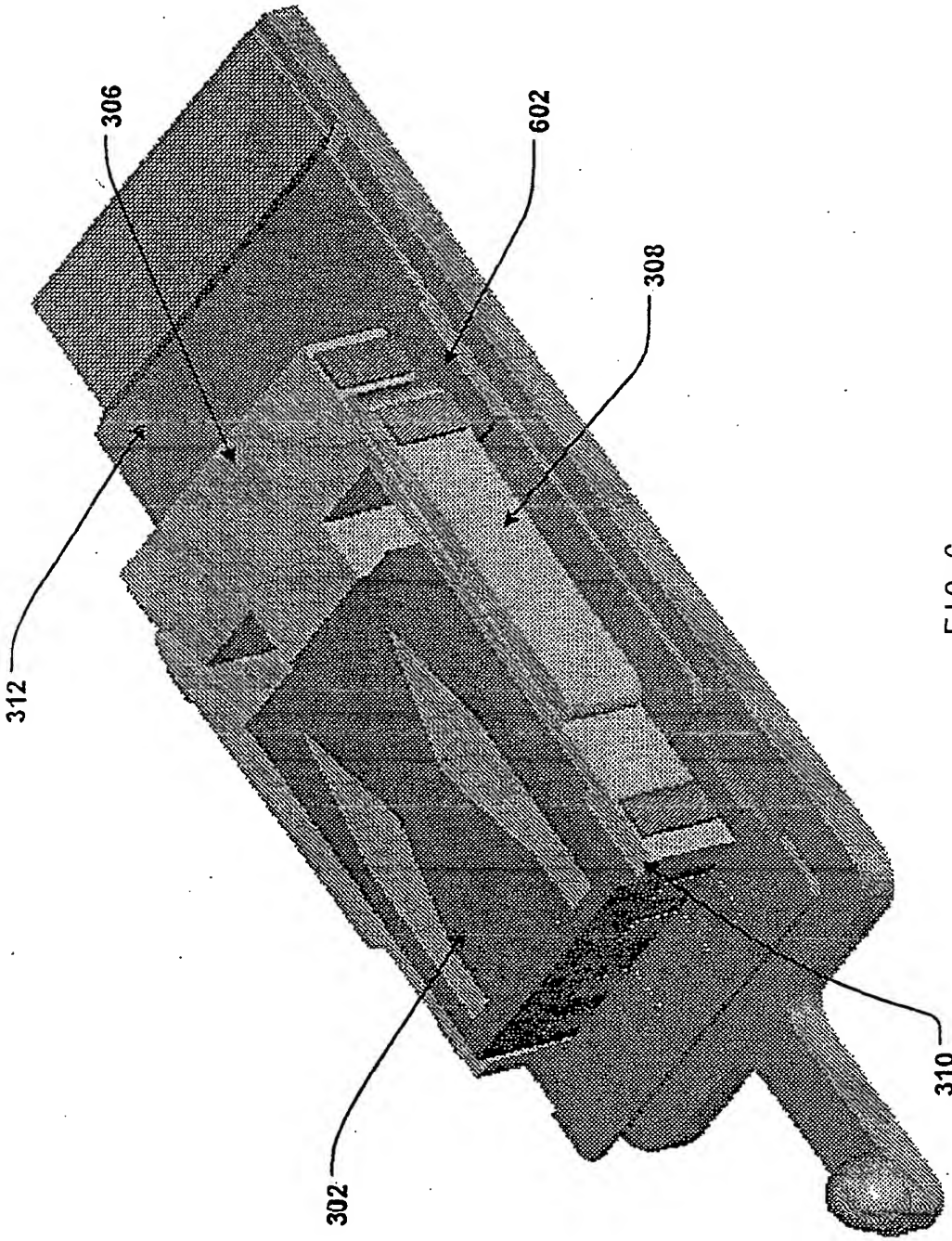

FIG. 6

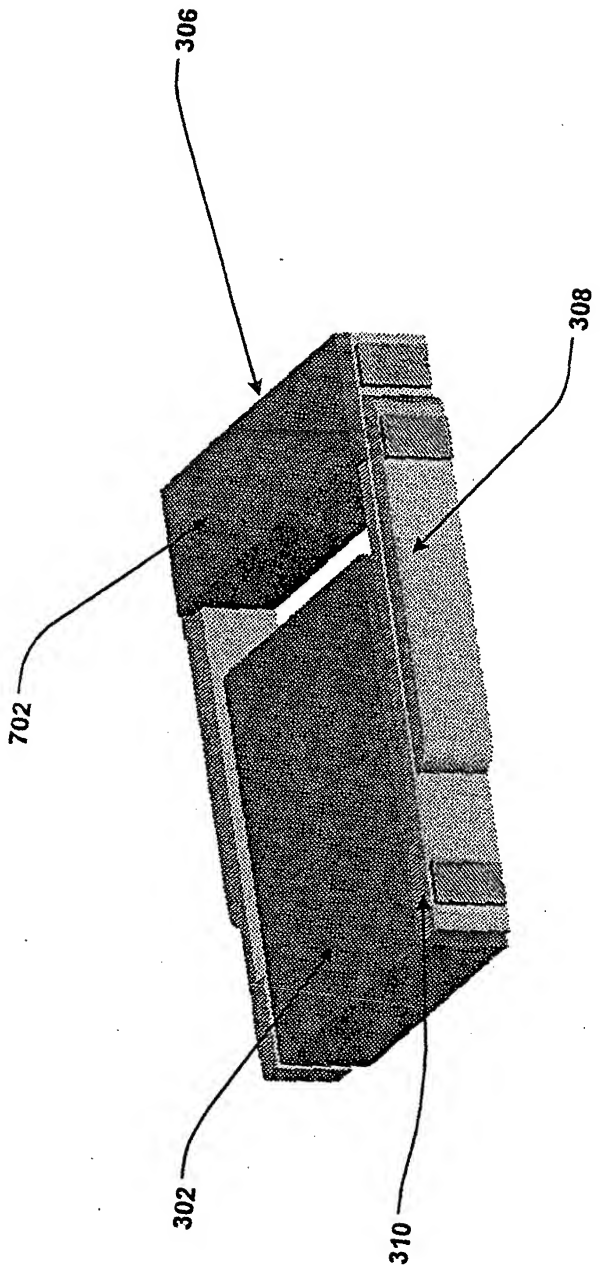

FIG. 7